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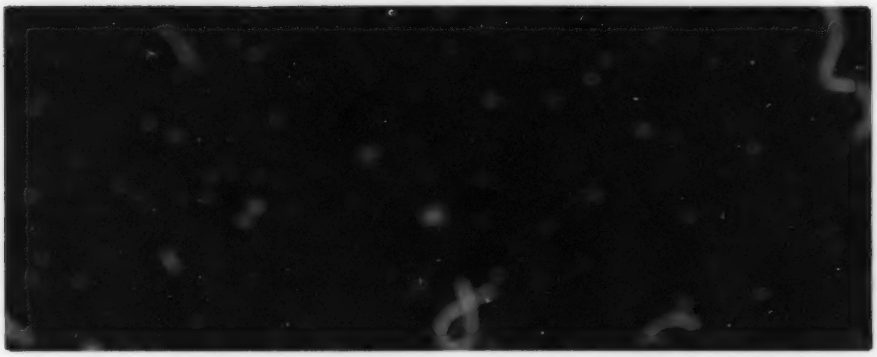

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Final Report
R-86-03-0051

Screening for Phytopath Resistance in Cereal and Pulse Crops for High Moisture Environs of Saskatchewan, Including Production Systems

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Final Report

ADF Project #R-86-03-0051

SCREENING FOR PHYTOPATH RESISTANCE IN CEREAL AND PULSE CROPS FOR HIGH MOISTURE ENVIRONS OF SASKATCHEWAN, INCLUDING IRRIGATED PRODUCTION SYSTEMS.

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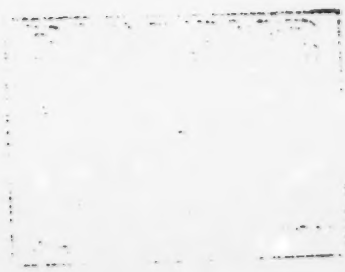

Abstract and Summary

A unique cost-efficient effective automated high frequency low intensity irrigation system specifically designed for the development and maintenance of foliar plant disease epidemics, in an otherwise unsuitable environment for those diseases, was developed assembled operated and modified at Saskatoon. This system has proven effective for screening for genetic resistance or tolerance to net-blotch in barley, ascochyta blight in lentil and septoria in wheat. In addition, a simple standard wheel move irrigation system has been utilized to screen for stem and leaf rust resistance in both wheat and barley. The development of this one of a kind system has demonstrated that, with this minor environmental modification, typically non-disease environments such as that normally encountered at Saskatoon, are actually more efficient locations for mass field screening for plant disease resistance since contamination due to indigenous non-target pathogens is eliminated.

From 1986-1989 this irrigated disease nursery has been utilized to effectively screen in excess of 400,000 genotypes as single plants and over 70,000 individual breeding lines of barley, lentil and wheat for resistance to the diseases noted. Superior disease resistant selections within each crop kind have been found and advanced for further testing and planned eventual release as new, more stable varieties for Saskatchewan producers.

Background and Objectives

Foliar crop disease problems and resultant losses have been on the increase in northern and eastern Saskatchewan. Several of these diseases have been increasingly widespread and damaging in irrigated crops, especially in the Outlook district. Intensive crop production, under high moisture conditions, whether via rainfall or irrigation, gives rise to greater incidence of foliar plant disease. Net economic losses to the producer are manifested in terms of actual yield/unit area reduction (some cases documented to date show losses in excess of 35%), in loss of grade and price due to effects on grain quality and in losses due to not having all possible cropping options open to remain competitive in the marketplace. The development of disease tolerant crop varieties will eliminate or minimize these losses.

"Clearly the most appropriate response to the challenge of disease control in crop production in the future is the intensified use of genetic resistance. It is by far the most economical, efficient, environmentally acceptable and long term sustainable means of controlling certain plant diseases in Canada" (Canadian Phytopathological Society, 1984).

The objective of this project was to establish an intensive irrigated field disease screening system at the University of Saskatchewan to allow plant breeders at the Crop Development Centre to incorporate tolerance or resistance to several critical diseases into new crop varieties designed for highly productive, high moisture, disease prone regions of Saskatchewan. Diseases of concern to the project included stem and leaf rust of wheat and barley, septoria in wheat and barley; net blotch, spot blotch and scald of barley; tan spot in wheat and ascochyta of pulses. The interest in new semi-dwarf wheats, winter wheat, two-rowed barley and lentil in Saskatchewan lends greater urgency to this concern as current varieties are highly susceptible to several foliar diseases.

These diseases are of particular concern to producers with irrigation capabilities since all these diseases thrive under high moisture conditions causing losses in product quality and yield.

Experimental Methods:

(a) Year 1 - Development, set-up and operation of an automated intensive irrigation system designed to provide frequent low intensity watering capability for the creation of an ideal environment for disease inoculation, infection and spread.

(b) Year 2 onward - Continued development, set-up and operation of the above. Beginning of actual disease screening for resistance to various disease noted in section 4.

Results and Discussion

I. Development of Irrigation System for Disease Screening

In addition to a small standard wheel move irrigation system which was used for cereal rust resistance screening in an area isolated from other cereal pathogen screening to avoid contamination, a unique computer-controlled high frequency low volume irrigation system was developed, set-up and made operational. This automated system enables the maintainance of high humidity (near 100%) by applying a relatively fine spray of water for short time periods throughout the cool, calm, night hours. For example, in areas used for net blotch screening in barley the system was run for 20 minutes at two hour intervals from 10:00 p.m. until 4:00 a.m. on a daily basis during the initial inoculation and subsequent infection stages. During this period, and for several hours following the last application, high humidity in the crop canopy was maintained despite a total application of only 3 mm of water.

Saskatoon's generally dry non-disease situation is an ideal location for this type of irrigation assisted pathology evaluation nursery, because of a lack of contamination from "naturally" occurring disease infestations. With this system at this location the plant breeder or pathologist can control the diseases for maximum benefit in the selection process. At other more moist, disease prone locations, contamination with several unwanted diseases at one time can make selection essentially impossible.

This system is unique in Canada and has the attribute of being long-lasting and relatively simple. It has proven to be very effective in developing controlled epidemics of net blotch in barley, ascochyta in lentil and septoria in wheat during the last three years of this project.

II Disease resistance screening 1986-1989

(a) Automated high-frequency low intensity system

(1) Net blotch (*Pyrenophora teres* f. sp. *maculata*) in barley (1987-1989):

Throughout the project period over 150,000 individual genotypes from 82 different hybrid combinations were screened for net blotch tolerance in space

planted nurseries. 9,668 F_5 lines, 3,336 advanced breeding program yield trial genotypes and 1,558 introductions, coop and regional test materials were screened in hill plots. Several of the breeding lines have been advanced to regional and cooperative trials. This nursery has been instrumental in the development of several two-row barley genotypes with exemplary net blotch tolerance both as potential cultivars and parents for future breeding work. An example of this is TR117 a two-row feed barley selection with an overall combination of disease resistance previously unavailable to Saskatchewan producers. TR117 was in its second year of Cooperative Registration tests in 1989.

(2) Ascochyta in lentil (1987-1989)

In excess of 10,000 individual lentil genotypes from hybrid combinations segregating for ascochyta resistance have been evaluated in various early generations from F_2 through F_4. The results of the selection process have been excellent with resistant selections to be advanced to yield trials in 1990.

In addition to the screening work above a new technique for resistance rating was developed using seed discoloration ratings of late harvested lentil as a simple and faster screening method than the traditional detailed % leaf area infected measurements.

(3) Septoria (Septoria nodorum and Septoria tritici) in wheat (1987-1989):

Over 2500 individual F_2 genotypes from several hybrid combinations were screened and selected for resistance. In addition, some 2600 F_3-F_5 families from several crosses and 150 backcross F_2 lines were also evaluated. The best selections have been advanced to yield trials or reused as parents in the spring wheat breeding program. Finally, 64 F_3 families derived from an interspecific Triticum aestivum/T. timopheevii cross were evaluated for resistance to S. nodorum.

(b) Standard wheel move irrigation system:

(1) Stem rust (Puccinia graminis f. sp. tritici) in barley (1987-1989):

During the project period some 110 early generation (F_2 and F_4) populations of approximately 2000 individuals each were screened for resistance in spaced single plant nurseries. At the advanced generation level (F_5 and up) a total of more than 12,500 breeding lines were evaluated. These efforts concentrated on two-row barley materials since currently available varieties lack resistance which is necessary for production in south-east Saskatchewan. Several rust-resistant lines are currently in cooperative pre-registration trials at least in part as a result of this project.

(2) Stem rust (P. graminis) and leaf rust (P. recondata) in wheat (1987-1989):

In excess of 27,000 spring, durum and winter wheat breeding lines have been tested for stem rust reaction. Since there is an absolute requirement for rust resistance for wheat cultivars for Saskatchewan this data is critical in the process of advancement of improved breeding lines. Only resistant selections are advanced to pre-registration trials. All Univ. of Saskatchewan breeding lines entering cooperative trials carry this resistance and the field screening

occurs in these nurseries.

In addition to the screening of breeding lines several studies in regard to the inheritance of rust resistane in wheat and the transfer of resistance genes from foreign sources have been conducted with the aid of this system.

Conclusions

A unique effective automated low intensity high frequency irrigation system specifically suited to the development of plant disease epidemics in otherwise unsuitable environment has been designed, assembled, operated and modified at Saskatoon.

The development of this system and another less complicated one has led to the development of effective, large scale field screening facilities for net-blotch of barley, ascochyta of lentil, septoria of wheat and rust in wheat and barley.

The development of this system has shown that a normally disease-free environment such as that at Saskatoon can be effectively modified to in fact provide a superior site for cost-effective plant disease resistance screening.

Over 150,000 individual early generation and 15,000 breeding lines of barley were screened for resistance to net blotch. Over 5,000 spring wheat breeding lines were screened for resistance to Septoria. In excess of 10,000 lentil breeding lines were screened for resistance to Ascochyta. Some 250,000 individual early generation and 40,000 advanced breeding lines of barley and wheat were evaluated for reaction to stem and leaf rust infection.

List of papers, posters and talks:

J. Tay and A.E. Slinkard, 1989. Ascochyta resistance in lentil. Sask. Pulse Crop Dev. Board Conf., Saskatoon.

J.L. Tay, 1989. Inheritance of resistance to Ascochyta blight on Lentil. M.Sc. Thesis dissertation, Univ. of Saskatchewan.

J. Tay and A.E. Slinkard, 1989. Transgressive segregation for Ascochyta resistance in lentil. Can. J. of Plant Sci. 69: 547.

J.A. Weller, B.G. Rossnagel and B.L. Harvey, 1989. Breeding for disease resistance in barley at the Univ. of Saskatchewan. Prairie Barley Symposium, Saskatoon, March.

J.A. Weller, B.G. Rossnagel and B.L. Harvey, 1989. Breeding for disease resistance in barley at the Univ. of Saskatchewan. Agric. Dev. Fund Conference, Regina, October.

B.G. Rossnagel, K.N. Kao and J.A. Weller, 1988. Use of anther culture for the rapid transfer of "spot-form" net blotch resistance from six-rowed to two-rowed barley. Can. J. Plant Sci. 69: 545.

B.G. Rossnagel, J.A. Weller and B.L. Harvey, 1987. Screening for resistance to the spot-form of net blotch in barley in western Canada. Canadian Society of Agronomy Annual Conference, London, August.

J.A. Weller, B.G. Rossnagel and B.L. Harvey. 1987. Screening for resistance to the spot-form of net blotch in barley in Western Canada. 13th American Barley Researchers' Workshop, Bozeman, July. Barley Newsletter, Vol. 31, 131.

Potts, D.A. and G.R. Hughes. 1989. Pathogenic variation in Septoria tritici. Can. J. of Plant Path. 11: 197 (abst.).

Potts, D.A. and G.R. Hughes. 1989. Inheritance and heritability of resistance to Septoria tritici in wheat. Canadian Society of Agronomy annual meeting, Montreal, Quebec. (in press)

Potts, D.A. and G.R. Hughes. 1989. Inheritance of resistance to Septoria tritici in wheat. Canadian Phytopathological Society regional meeting, Saskatoon, Saskatchewan.

Financial Statement

Will be supplied by U. of Sask. Business Office

List of Personnel

(a) Technical Staff:

Naidoo, T.	1989: 4 months @ 100%
McGrath, B.	1989: 1 months @ 100%
Morris, J.G.	1988: 4 months @ 100%
	1987: 6 months @ 76%
Boyer, J.F.	1988: 4 months @ 100%
	1986: 6 months @ 100%

(b) Consultants - Paid from other sources
Rossnagel, B.G. (Senior Scientist)
Harvey, B.L. (Professor)
Knott, D.R. (Professor)
Baker, R. (Professor)
Slinkard, A. (Senior Scientist)
Hughes, G. (Assoc. Professor)
Gore, R. (Field Superintendent)
Sharman, K. (Administrative Asst.)
McLean, J. (Payroll Clerk)

(c) Summer Students:

McGrath, B.J.	1989: 4 months @ 100%
Labelle, T.	1988: 4 months @ 100%
Yule, S.	1987: 3 months @ 100%

Equipment Purchased:
Nil